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Influence of Product Type on Purposes of Using ICT Applications in the Malaysian Research Institutes

Md. Nor Hayati Bin TAHIR* and Hitoshi MITOMO*

Abstract

The information and communication technology (ICT) development and expenditure in Malaysia has been growing since the start of the ICT evolution to promote the integration, network and sharing of information among sectors. Research institutes play an important role to support the economic and technological growth through emergence of new product goods, services and processes. This paper is based on the questionnaire survey that was conducted on the researchers at the government research institutes (GRI) and private research institutes (PRI) that use ICT applications. The objectives are to identify the purpose of using ICT applications to signify the presence of information sharing in the development of different product types at the diffusion level of market finding and commercialization. From the finding, it is found that the purpose of using ICT applications for the sharing of information in the GRI and PRI is influenced by product type. Portal that diffused to the level of market finding acts as the tool for sharing information for researchers in GRI for product goods, service and process. In contrast, groupware that used for market finding in PRI is found to be significant only for product service. PRI share information by using the intranet for commercialization, while in contrast, GRI that lack of information to commercialize the product have to rely much on information from the external source and this contributes the usage of groupware.

JEL Classification: D85, O33, Z13
Keywords: Researcher, Innovation, Critical Mass, Level of Diffusion
Abbreviations: Information and Communication Technology (ICT), Research and Development (R&D), Government Research Institutes (GRI), Private Research Institutes (PRI), Institutes of Higher Learning (IHL), Multinational Company (MNC), Malaysian Science and Technology Information Center (MASTIC), Gross Expenditure on R&D (GERD), Gross Domestic Product (GDP).

1. Introduction

The ICT development and expenditure in Malaysia is increasing every year since the start of the ICT evolution to promote the integration, network and sharing of information among sectors. The growth is corresponding to the innovative development of the ICT that evolved since the early era involving personnel, accounting and payroll. The establishment of national data processing from 1985 to 1990 promotes wider application of ICT in public and private sectors.

* Graduate School of Information and Telecommunication Studies, Waseda University, 1-3-10, Nishi-Waseda, Shinjuku-ku, Tokyo, 169-0051, Japan
E-mail: mdyati60@akane.waseda.jp, mitomo@waseda.jp
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The development of the ICT was entrusted to promote the sustainable economic development of the nation. Till date, the private sector plays the key role in contributing to the economic and technology development of the nation. The private sector that consists of export orientated multinational companies (MNC) in manufacturing and trading, were the result of economic liberalization and funding incentives. The advance technology imported by the MNC was operated in Malaysia producing new products and processes through the research and development (R&D) activities locally in the private sector research institutes (PRI). ICT applications are used for R&D activity not only in the private sector but also in the government sector (public sector) in the government research institutes (GRI).

The ICT applications contribute to R&D activity in producing newly emerging product goods, services and processes in GRI and PRI. From the previous survey, it is found that information sharing is critical at the initial stage of innovation development of product, the market finding, and the final stage of the innovation development, the commercialization. For both research institutes, portal and groupware diffused at the level of market finding whereas portal and intranet is diffused at the level of commercialization. This survey is an attempt to examine the usage of ICT application in the GRI and PRI at the diffusion level of market finding and commercialization. The usage of portal, groupware and intranet are for sharing of information among the researchers in the research institutes.

The purpose of using of ICT applications for the sharing of information in the GRI and PRI has been found to be influenced by the product type. At the level of market finding, portal is used by researchers in GRI for product goods, service and process; whereas GRI where groupware found to be significant only for product service. In commercialization, researchers in PRI share information by using the intranet where the information is shared within the organization, but GRI use groupware for the sharing of information with external sources for commercialization of product.

2. Literature

Metcalfe [11] defined network as economic activity to internalize the effects of transmitted information. It falls within the perimeter of non-market device replaces the formal market and organization integration. The members of the network seek coordination with the information generating institutions. He further supported that firms in some industries are developing networks of international alliance to share information for the development of the technology. From the interconnection, information is spillover to affect others and compete in R&D intensive activities. Foray [5] stressed the phenomena, as the result of networking is the increase in the number of members that are capable of producing, diffusing and absorbing the information.

Finch [4] noted that the emerging of networking had change from normal trend of innovation. The result of networking is the sharing information from the external sources, which will promote R&D activities. The idea-generated from the clear information creates demand for new product. Gallouj [6] defined innovation as any change that affects one or more terms of one or more vectors of those characteristics (technical, service or competence) that are brought about by the mechanisms of evolution or variation, disappearance, appearance, association, dissociation or formatting. In this study, the innovation activity is

the emergence of new product and process where economic and social value is created from the information acquired by using the ICT applications. Campbell and Cooper [1] stressed that the innovator lacks of information internally could shorten development time and reduce costs of the new product through network. The phenomenon will further enhance with the emergence of the ICT where the link between innovators and the customer has been greatly increased.

Dahan and Hauser [3] stressed that the emerging of ICT will rapidly and economically incorporate innovators and customers in the product development system by enhancing the communication, conceptualization and implementation. Carvalho and Ferreira [2] emphasized that ICT supports the information sharing through the network that in turn used for product development. Carvalho and Ferreira [2] identified ICT applications that have some common feature to support information flow and sharing of information. Six ICT applications were considered in this survey that is commonly used in the research institutes in Malaysia. They are intranet, electronic document, groupware, workflow, innovation support software and portal.

Intranet is private networks that may facilitate the sharing of dynamic and linked information passively where the user has to pull the information that emphasizes internal information in a close organization environment such as the retrieval of corporate documents. Electronic document systems are repositories of corporate documents to be retrieved by members of the organization that can contribute and generate office activities. Groupware is designed to help members that are dispersed geographically and having the needs to work together. Workflow is a system to support standardized business processes that require ordered and structured information sharing. Innovation supports software used in the product design process is to create virtual environment in the process of R&D. Portal is to integrate the heterogeneous information sources with standard interface to users where information from various departmental intranets is consolidated.

The usage of the ICT applications by the researchers in the research institutes may result diffusion. The Linked Chain Model introduced by Kline [8] consists of five pathways for innovation processes. Underlying the model, it involved the process of market finding, analytic design, design and test, redesign and produce and commercialization. These processes run one after the other through the innovation development. On top of those stages, it involves knowledge and research. The elements of the model are illustrated in Figure 1.

The linked processes are actions running through time. The information must be shared between researches and chain-of-innovation. Lacking of information in any five stages in

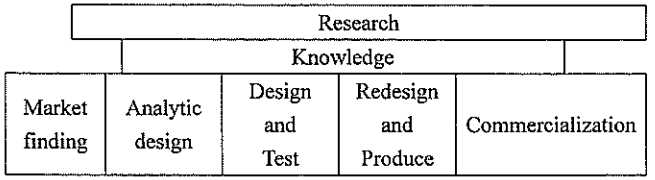

Figure 1 The Linked Chain Model

chain-of-innovation, one must refer to the stored information, whether literature or expert, to proceed with the innovation. Adequate information gathered from the pool of information will allow the innovation processes to continue to the next step in the chain-of-innovation. Inadequate information researchers can activate research activity that imposed high cost and time. The sharing of information will be more efficient if supported by the ICT applications along the stages in the innovation development processes. Communication between different stages must be collaborated for efficiency in an organization.

Rogers [14] defined diffusion as a process of communication through certain channel that creates the adoption of technology to a critical mass public. Four elements of diffusion are the innovation, communication channel, time and social system. The innovation is idea of technology that is perceived as new by the adopter. In this survey the information needed by the researchers act as new information to be used for innovation and R&D activity. ICT applications act as the communication channel is a tool by which the information is been shared by the user. Time is the period taken by the user to decide whether to except or reject the technology and the social system is the interrelated units that engage in the joint problem-solving activity. In this survey, the achievement level of critical mass is defined by the level at which the ICT applications is been used dominantly by the researchers.

3. Background of the Survey

The ICT expenditure in Malaysia is manifesting the focus of economic and technology activity based on the information as shown in Table 1. Strategically, the ICT policies designed play dual roles in moving Malaysia toward knowledge society and knowledge-based economy. First is the ICT as a new sector of economic growth and second the social as the ICT enabler. The establishment of Multimedia Super Corridor (MSC) is to promote the

Table 1 ICT Expenditure in Malaysia

Year	1990	1995	1998	2000	2001	2002	2003
RM million	1,300	4,438	4,840	5,910	6,501	6,512	7,863

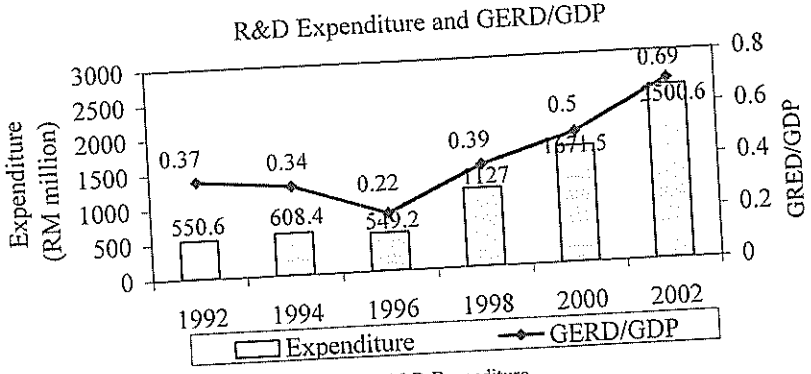

Figure 2 R&D Expenditure

emergence of ICT as a new sector for the technology and economic growth supports by high quality ICT infrastructure.

In 2004, the ICT industry expenditure expanded to 13% as compared to 2003 where manufacturing sector contributed to 18% of the expenditure (MITI 2005). The usage of ICT is more slanted toward an administration in the organization. There are 10,248 websites (89%) registered in 2004 for the purpose of internal affairs and commercial. It is clear that the ICT is meant for network and communication, but the effect on efficiency and productivity is still uncertain.

To self-sustain the economic and technology growth, innovation and R&D activity should be intensified. Intensification of innovation and R&D activity has been initiated by increasing the expenditure as shown in Figure 2.

Malaysia's target to spend 2% gross expenditure on R&D (GERD) over gross domestic product (GDP), GERD/GDP, in 2000 has not been achieved. Nevertheless, the presence of outsourcing of R&D shows positive indication toward sharing of information between sectors and this is an element to look for in indicating the demand of R&D activity. Table 2 shows the foreign outsourcing expenditure is on the reducing trend for GRI and IHL ; meaning that the outsourcing activity is turning inwards towards to the local R&D institutions. Nevertheless, the foreign outsourcing for PRI is still at very high percentage of the R&D expenditure.

Private sector's outsourcing expenditure amounted to RM 285.6 million in the year 2002 with 78.7% spent for foreign outsourcing. From this fact, three issues can be deduced, first is that local institution may not be capable yet in term of expertise and technology. Second is that the private sector are outsourcing the activity to their mother company overseas

Table 2 Outsourcing Expenditure

Year	GRI		IHL		PRI	
	Local	Foreign	Local	Foreign	Local	Foreign
1992	99.2	0.8	na	na	0.6	99.4
1994	12.4	87.6	na	na	16.5	83.5
1996	99.4	5.6	na	na	7.2	92.8
1998	71.3	28.7	63.8	36.2	18.2	81.8
2000	97.3	2.7	94.0	6.0	8.5	91.5
2002	57.3	42.7	96.5	3.5	21.3	78.7

Source : MASTIC 2000 National Survey of Research and Development Report.

Table 3 Number of patents granted in Malaysia

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Residents	14	21	29	79	52	21	39	24	18	32
Foreigners	1,270	1,608	1,724	1,722	734	545	682	381	1,452	1,460
Total	1,284	1,629	1,753	1,801	786	566	721	405	1,470	1,492

Source : Malaysian Science and Technology Information Centre (MASTIC)

because they are MNC. Third is that local institution is lacking of networking with the private sector.

Internationally, Malaysia with GERD/GDP of 0.69% in 2002 is slightly ahead as compared to some ASEAN neighbors like Indonesia and Philippines with GERD/GDP of 0.20% (1995) and 0.22% (1997) respectively. Singapore leads the ASEAN nation with 1.89% in 2000, well ahead of other members. Many countries registered a high GERD/GDP ratio as compared to Malaysia, especially the developed country like Japan and United State with 2.80% (1999) and 1.65% (1999) respectively. Finland registered a record high of 2.92% in 1998.

The output of the R&D activity is still uncertain to complement the expenditure. The number of projects done by the researchers show a positive trend with an increase of 400% from 1998 (1,274) to 2002 (6,372). Nevertheless, patents granted for the new emergence product are mostly to the foreign researchers as shown in Table 3.

Internationally, the number of patents granted to Malaysia shows an increasing trend since 1995, ahead of other ASEAN countries except Singapore as shown in Table 4.

From the explanation, it is clear that focus must be given to intensify the output of the research institutes that support by the usage of ICT considering factor below:

i. The negative trend achievement shown by ratio of expenditure per project in 1998 to 2000 as in Figure 3.

Table 4 Number of patents granted in United State Patent Office

	1993	1994	1995	1996	1997	1998	1999	2000	2001
Indonesia	5	9	7	2	12	10	5	14	10
Malaysia	19	16	8	24	29	35	34	47	56
Philippines	5	1	4	4	21	19	21	12	15
Singapore	44	59	61	97	100	136	152	242	304
Thailand	17	8	10	11	11	21	29	30	47

Source: Technology Assessment and Forecast (TAF) Database, United States Patent and Trademark Office, USA

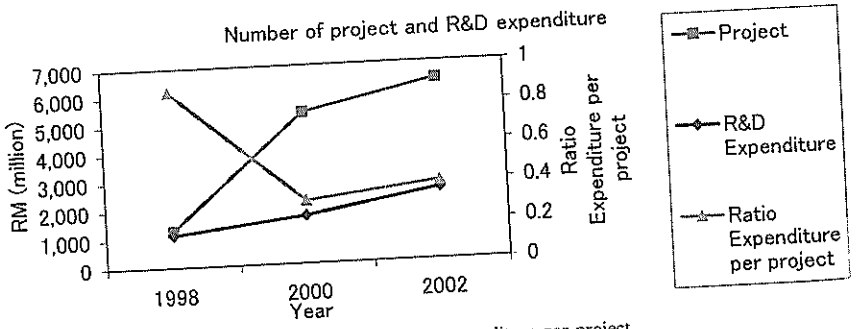

Figure 3 Ratio of R&D expenditure per project

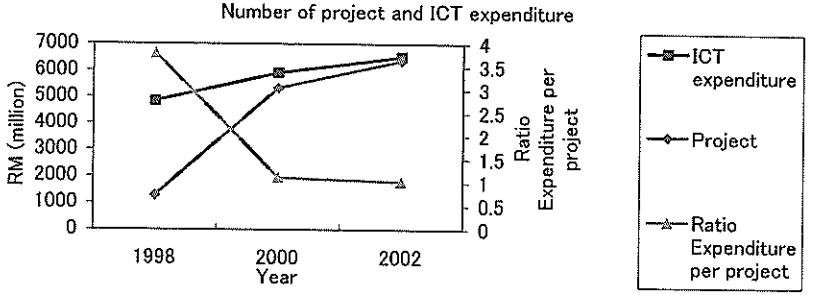

Figure 4 Ratio of ICT expenditure per project

Table 5 Diffusion level of ICT applications

	Market finding	Analytical design	Design and Test	Redesign and Produce	Commercial
Portal	Overall GRI PRI				
Groupware	Overall PRI				GRI
Workflow process		PRI		Overall GRI	
Electronic documents		Overall GRI PRI			
Intranet					Overall GRI PRI
Innovation support software			Overall GRI PRI		

ii. Presence of demand from the outsourcing activity.

iii. The ratio of ICT expenditure per project shows negative trend in 1998 to 2002 as shown in Figure 4 that implies the ICT usage may promote efficiency.

From the scenario, investigation should be done on the usage of ICT application in research institutes. The problem statement of this survey is to what level the ICT applications diffused in GRI and PRI.

Presence of collaborative R&D activity as in Table 2 implies that information is shared at the initial stage of product development. Previous survey by Md Nor and Mitomo [10] found that the ICT applications contribute to the innovation development and R&D activity in GRI and PRI. The ICT applications diffused is influence by GRI and PRI. From the survey, market finding and commercialization are important level for economic value of the product. Portal and groupware diffused at the level of market finding but groupware and intranet is diffused to the level of commercialization in both research institutes as shown in Table 5.

The purpose of usage of the ICT applications may differs for different product type produce by both research institutes at the point of diffusion. Three product types are

considered in this survey namely the product goods, service and process.

3.1 Study Objective

The increase of ICT expenditure should in turn increase the intensification of usage and network for sharing of information. The usage of ICT applications in the research institutes may contribute to the sharing of information among researchers and the external source of information. The main objectives of this survey are:

i. To examine the purpose of ICT usage with regard to different types of product.
ii. To examine the purpose of using portal, groupware and intranet at the point of diffusion.

4. Methodology

In this section, explanations about the conceptual framework, working statement, model of analysis and sample are given.

4.1 Working Statement

In this survey, three ICT applications identified from the previous survey by Md Nor and Mitomo [10], that diffused at the level of market finding and commercialization have been considered for the purpose of the analysis. The ICT applications are portal, groupware and intranet. Researchers working in the research institutes use the ICT applications to acquire information during market finding and commercialization process. The purpose of usage of ICT applications can be determined by analyzing the indicators of the three ICT applications. From the relationships, the working statements to be examined in the survey are:

- GRI and PRI have different purposes of using ICT applications in term of frequency of usage depend on product type.

4.2 Model of Analysis

In this subsection, the relationship between the frequency of using ICT applications and purposes of using ICT applications for different product type are explained and illustrated as

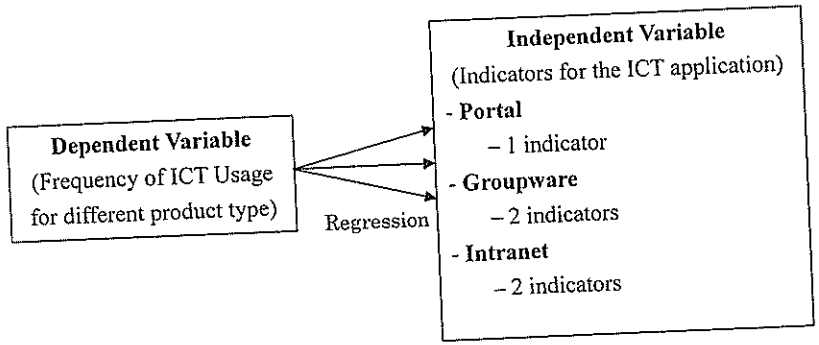

Figure 5 Model of analysis

in Figure 5.

The dependent variable used in this survey is the frequency of using ICT application measure from 1-5 where 1=almost never and 5=always. To examine the purpose of using ICT applications that acts as independent variable, indicators are established to represent the type of ICT applications relevant to each purpose of using ICT applications. Questions were asked on how the respondents perceived the indicators contribute and related to the development of the product in innovation and R&D activity that the researchers undertake. The measurements of the indicators range from 1-5 where 1=strongly disagree to 5=no opinion. The independent variable to explain the usage of portal developed in the questionnaire is ICT application used to make contact with expert in certain field. Two indicators representing the usage of groupware namely information posted by e-mail and information received by e-mail. Two indicators develop to represent the usage of intranet are retrieving data information and storing data information. Comparison of the purpose of using ICT applications has been applied for product goods, service and process.

To analyze the relationship, regression analysis is applied where the coefficient and t-value is used to determine the relative importance of each indicators of the independent variable involved in usage of the ICT applications. The significant indicator of the independent variable will identify the purpose of using ICT applications that is related to a type of product. As the result, a set of effective purposes of using ICT applications will be determined for the type of product.

4.3 Sample

Primary data had been gathered through questionnaires distributed and e-mail sent to the researchers in GRI and PRI. In this survey, 800 questionnaires had been distributed and 700 e-mails had been sent to the research institutes vary from agriculture, microelectronic, nuclear technology, remote sensing, telecommunication services and telecommunication product, financial and electronic product. Structured interviews were carried out to 20 randomly selected researchers. Questions asked during the interviews were about the issues of motivation to initiate the project and commercialization for the economic return of the project.

5. Analysis

The data gathered were analyzed by using the SPSS Version 11.0 for Windows. Two type of analysis were done, namely the general distribution of respondents and analytical statistic.

5.1 Distribution of the Respondents

The survey was performed from November 2004 to January 2005. From 1,500 questionnaires distributed and e-mailed, 256 respondents (17.07%) answered the questionnaires, of whom 150 respondents represented GRI and 106 respondents represented PRI, as shown in Table 6. The 12 GRI and 11 PRI represented[2] 17.9% and 5.6% the research institutes

[2] 67 GRI and 195 PRI were involved in the survey reported in 2000 National Survey of R&D by MASTIC.

Table 6 Distribution characteristic of respondents

		Frequency	%	Population	%
Gender	Male	161	62.9	4,481	73.3
	Female	95	37.1	1,632	26.7
Sector	GRI	150	58.6	3,809	62.3
	PRI	106	41.4	2,304	37.7
Years using ICT applications in workplace	<5 years	129	50.4	n.a	n.a
	6-10 yrs	57	22.3		
	11-15 yrs	47	18.4		
	16-20 yrs	17	6.6		
	>21 years	6	2.3		

respectively from various sectors as mentioned in section 4.3.

Total researchers in GRI and PRI are 7,263 personnel (40.8%) of total researchers in Malaysia (National Survey of R&D, 2002) including the researchers in IHL. The gender balance in this study is very close to reality, in that males represent 62.9% of the respondents as compared to the total male population of 67.9% and female respondents' percentage is 37.1% as compared to the female population of 26.7%. The factor of sector also shows a reasonably close match between sample and reality, in that the respondents from GRI stand at 58.6% and PRI at 41.4% as compared to the sectored population of 62.3% and 37.7% respectively.

Descriptively, the respondents are representing the researchers in both research institutes after considering 2 factors:

i. The respondents are from various sectors and activities research institutes.
ii. The respondents were randomly selected from various departments representing the research institutes.

The respondents have done a total of 463 projects in the period of the last three years before the survey had been carried out. From the survey, GRI scored 61.11% for service and 55.62% for process but PRI scored 52.87% for product goods.

5.2 Analysis and discussion

In this survey, regression analyses were applied to examine the influence of the indicators that act as the purpose of using ICT applications for the product goods, service and process. From this survey it was found that the mode of the information flow is influenced by the product type.

5.2.1 Purpose of using ICT applications for product goods

Descriptively, it is found that 87 (18.79%) projects involved product goods in the last three years in both research institutes before the survey. From 87 projects, GRI scored 41 projects and PRI, 46 projects.

Regression analysis was conducted to examine the purpose of using ICT applications that was influenced by product goods. The analysis shows that the model fits well in estimating the purpose of using ICT applications with the adjusted R square of 0.70. The

analysis of variance shows that $F(5, 81) = 41.58$ at significant level of Sig.$=0.001$ as shown in Table 7.

At the level of diffusion, the usage of ICT applications product goods is related to the usage of portal and intranet. ICT to establish network with expert as the indicator for usage of portal is found to be significant with standardized coefficient of 0.24 with t-value of 2.90 and significant at Sig.$=0.001$. At the level of market finding, portal is used by the researchers to establish network with expert for information sharing during that level of innovation development.

Further analysis on usage of portal at the diffusion level of market finding that contributes to the development of product goods found that 51.35% and 48.65% of the product goods developed by GRI and PRI respectively as shown in Table 8. The result implies that in GRI and PRI, portal is used for the purpose of sharing information to initiate the development of product goods.

Store data information as one of the indicator for intranet is also found to be significant with standardized coefficient of 0.51 2 with t-value of 2.99 and significant at Sig.$=0.001$. Intranet is diffused to the level of commercialization for GRI and PRI.

From the result in Table 7, it is found that, for product goods, intranet is used for storing the data information. In both research institutes, the data information is stored in the repository system of the organization to be used by other researchers. It implies that information is been shared by way of storing the information that is later used by others.

Table 7 Model for product goods

Indicators	Beta	t-value	Sig.
ICT to establish network with expert	0.24*	2.90	0.00
To post information using e-mail	−0.07	−0.23	0.82
To received information using e-mail	0.28	0.95	0.34
Retrieve data information	−0.02	−0.19	0.85
Store data information	0.51*	2.99	0.00
R Square	0.70		
F-value	41.58		
Significant at Sig.<0.05			

Table 8 Product goods involved usage of portal and intranet at point of diffusion

	Using portal for market finding		Using intranet for commercialization	
	Number of project	Percentage (%)	Number of project	Percentage (%)
GRI	19	51.35	10	40.00
PRI	18	48.65	15	60.00
Total	37	100.00	25	100.00

Further analysis on usage of intranet at the diffusion level of commercialization found that 25 projects were involved in using intranet for commercialization for the last three years before the survey is done. GRI contributes to 40.00% of the product goods where the information been shared by using intranet at the commercialization level and PRI contribute 60.00% of the product goods for the same as shown in Table 8.

From the survey, it implies that for PRI, information for commercialization is shared within the organization. This result supports the finding of the interviews done with five researchers from PRI that during commercialization level, the information is shared with the marketing department of the organization for commercialization. It implies that commercialization of product goods in PRI involved the sharing of information by the usage of intranet within the organization.

5.2.2 Purpose of using ICT applications for product service

Descriptively, it is found that 198 (42.76%) projects involved product service in the last three years in both research institutes before the survey. From 198 projects, GRI score 121 (61.11%) projects and PRI 77 (38.89%) projects.

Regression analysis shows that the indicator fairly fits well in estimating the model with the adjusted R square of 0.56. The analysis of variance shows that $F(5, 192)=48.83$ at significant level of Sig.=0.001 as shown in Table 9.

Analysis to examine indicators to explain the purpose of using portal, groupware and intranet for market finding and commercialization for product service found that three indicators are significant for GRI and PRI. For product service, ICT used to establish network with expert that represent usage of portal is significant with standardized coefficient of 0.38 with t-value of 4.92 at significant level of Sig.=0.001. Groupware represented by indicator to received information using e-mail found to be significant with the standardized coefficient of 0.33 with t-value of 2.25 at significant level of Sig.=0.03. Store data information, indicator representing usage of intranet is the third indicator that is significant with standardized coefficient of 0.24 with t-value of 2.50 at significant level of Sig.=0.01.

From the result, the usage of portal to establish network with expert and the information from source are received by way of e-mail contributes to the sharing of information. At the level of commercialization of product service, intranet is used implying that the information comes from within the organization.

Table 9 Model for product service

Indicators	Beta	t-value	Sig.
ICT to establish network with expert	0.38*	4.92	0.00
To post information using e-mail	−0.17	−1.17	0.24
To received information using e-mail	0.33*	2.25	0.03
Retrieve data information	0.13	1.43	0.16
Store data information	0.24*	2.50	0.01
R Square	0.56		
F-value	48.83		
Significant at Sig.<0.05			

Table 10 Product service at point of diffusion

	Using portal for market finding		Using groupware for market finding		Using intranet for commercialization	
	Number of project	(%)	Number of project	(%)	Number of project	(%)
GRI	64	65.31	18	48.65	10	18.87
PRI	34	34.69	19	51.35	43	81.13
Total	98	100	37	100	53	100.00

Table 11 Usage of groupware for commercialization

	Product Goods		Product Service		Process	
	Frequency	%	Frequency	%	Frequency	%
GRI	18	78.26	17	70.83	31	83.78
PRI	5	21.74	7	29.17	6	16.22
Total	23	100.00	24	100.00	37	100.00

Further analysis on usage of portal at the diffusion level of market finding that contributes to the development of product service found that 65.31% and 34.69% of the product service developed by GRI and PRI respectively as shown in Table 10.

Product service that uses groupware at the level of market finding contributes 18 and 19 projects for GRI and PRI respectively. Nevertheless at the level of commercialization, the usage of intranet for sharing of information found that PRI and contributes 81.13% and GRI 18.87%. From the finding, it implies that for product service, using portal is dominant at GRI for the level of market finding and intranet is dominant at PRI for the level of commercialization. Once again, the results of interviews supported the findings for the commercialization of product at PRI.

In GRI, groupware is diffused at the level of commercialization as shown in Table 5. Further analysis on commercialization of product found that groupware is been used dominantly in GRI for all kinds of product with the score of 18 for product goods, 17 for service and 31 for process. The number of project that involve sharing of information by groupware for commercialization in GRI is consistently more than the score of PRI for all kinds of products as shown in Table 11. This finding is supported by the result of the interviews with 15 researchers from GRI where in commercialization ; longer time is needed and required vast information to commercialize the product.

5.2.3 Purpose of using ICT applications for process

Descriptively, 178 (38.44%) projects in the last three years before the survey involved process by GRI and PRI. 99 (55.61%) projects were done by the researchers in the GRI and 79 (44.38%) projects were done by the researchers in the PRI.

Regression analysis conducted shows that the indicator fairly fits well in estimating the

Table 12 Purposes of using ICT applications for process

Indicators	Beta	t-value	Sig.
ICT to make network with expert	0.33*	5.05	0.00
To post information using e-mail	0.02	0.21	0.83
To received information using e-mail	0.06	0.67	0.50
Retrieve data information	0.51*	2.82	0.01
Store data information	0.01	0.01	0.99
R Square	0.67		
F-value	74.22		
Significant at Sig.<0.05			

Table 13 Product process involved usage of portal and intranet at point of diffusion

	Using portal for market finding		Using intranet for commercialization	
	Number of project	Percentage (%)	Number of project	Percentage (%)
GRI	58	67.44	24	42.11
PRI	28	32.56	33	57.89
Total	86	100.00	57	100.00

model with the adjusted R square of 0.67. The analysis of variance shows that $F(5, 172) = 74.22$ at significant level of Sig.=0.001 as shown in Table 12.

Analysis to examine the usage of portal, groupware and intranet at the point of diffusion of market finding and commercialization for product process found that 2 indicators are significant. ICT to establish network with expert representing usage of portal with standardized coefficient of 0.33 and t-value of 5.05 significant at Sig.=0.001 and retrieve data information representing usage of intranet with standardized coefficient of 0.51 and t-value of 2.82 significant at Sig.=0.01. From the result, the sharing of information during the development of product process in the research institutes is by way of portal and intranet. Portal is used to establish network with expert who act as the reference point during the process development. Intranet as the tools to access to organization document is used during the commercialization level of the process.

Further analysis found that 86 (48.31%) projects involving the usage of portal at the level of market finding and 57 (12.31%) projects involving the usage of intranet for commercialization, the point of diffusion of the ICT applications as shown in Table 13. From the finding, GRI need more information before initiating the innovation and R&D activity involving process. In commercialization, PRI shows more dominant using the intranet by sharing the information within the organization. This result supports the result of the interviews where commercialization needs sharing of information between the researchers and the marketing department in the organization.

Table 14 Result of the analyses at the point of diffusion of ICT applications

	Research institute with higher project score at point of diffusion		
	Portal	Groupware	Intranet
Product goods	GRI	Not significant	PRI
Product service	GRI	PRI	PRI
Process	GRI	Not significant	PRI

5.2.4 Discussion

From the survey, it was found that the purpose of using ICT applications for the sharing of information in the research institutes is influence by the type of product. From the analyses in section 5.3, the findings can be simplified as shown in Table 14. At the point of diffusion of market finding and commercialization, obvious trend of portal and intranet usage can be seen for GRI and PRI.

Portal that diffused at the level of market finding, the initial stage of innovation development, is obviously been used by the researchers in GRI for the development of all product type. This implies that much information is needed by the researchers from the GRI to initiate the product that comes not only from within the organization but also from across the boarder where portal serve the purpose, that in turn promotes the usage of portal for sharing of information. Portal promotes the development of network with expert that contributes to information gathering for the development of certain product. In contrast for the PRI, groupware is used for product service at the diffusion level of market finding.

At the level of commercialization, intranet is obviously used by the PRI for all kind of products. From this finding it implies that the information is shared within the organization for commercialization for all kind of products where the mode of the information flow is by way of using intranet. The marketing department that involved directly with the product in the market may act as the source of information for the researchers in PRI to develop new emerging product or process. In contrast, researchers in GRI dominantly use groupware to share and acquire information to commercialize the products. Groupware is used to acquire and share information not only within the organization but also from other sources.

The implication of this finding is that local applications to disseminate information should be intensified and developed, that involves new findings of product done by expert in all research institutes including GRI, PRI and IHL. Local content may contributes to the availability of information about local product and the researchers can share the information in the content. As the information is important to initiate the development of new product, commercialization is economically critical for the return of the effort that put forward by the researchers.

6. Conclusion

Initiating and commercializing a new emerging product and process is essential for the technology and economic development. ICT applications play an important role in storing

and disseminating the information that could contribute to the development of new emerging product by the researchers in the research institutes.

The usage of ICT applications act as the sharing of information in the GRI and PRI found to be influenced by the product type. Portal that diffused to the level of market finding acts as the tools for sharing information for the researchers in GRI for product goods, service and process. In contrast, groupware that acts as the tools for sharing information for market finding in PRI found to be significant only for product service. In commercialization, PRI share information by using the intranet. Information is shared within the organization because the information needed by the researchers depends much on the marketing department of the organization. In contrast, GRI that lack of information to commercialize the product have to rely much on information from the external source and this contributes the usage of groupware as the tool for sharing information.

In general, information that is available in the ICT applications could contribute to the development of new emerging product. Intensifying the development of local content could promote information sharing by local researchers in the research institutes in Malaysia. The ICT policy about developing local content is timely, to promote the sharing of information between researchers and also the public to disseminate information that could contribute to the emergence of new product for the technology and economic development.

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